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Review of environmental sustainability assessments of aquaculture systems: main findings and outlook

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Aquaculture has been growing quickly during the last decades and, albeit often regarded as sustainable by nature, this sector remains associated with several environmental impacts (e.g. aquatic eutrophication, ecotoxicity impacts in local ecosystems). To assess environmental sustainability of food production systems, one of the most commonly used tools is life cycle assessment (LCA), which quantifies the impacts of a system along its whole life cycle. Over the past decades, LCA has been applied to aquaculture systems, but what are the lessons we learn from them? To address this question, we performed an unprecedentedly comprehensive critical review encompassing 65 LCA studies of aquaculture systems published in peer-reviewed journals. We conducted a statistical meta-analysis of the results, and performed comparative analyses of the fish farms and practices, accounting for differences in intensity, technology, feed conversion ratio (FCR), and types of farmed species. Overall, we found that FCR, the species and the technology have a significant influence on the environmental impacts per produced output. The intensification of the aquaculture systems is usually associated with environmental burden-shifting from local to global impacts. Polyculture is a promising candidate for more sustainable aquaculture systems, especially integrated agriculture-aquaculture and aquaponics. Therefore, in the quest for more environmental-friendly aquaculture systems, we recommend to (1) focus on reducing the FCR and choose environmental-friendly diets (e.g. replacing fish meal and fish oil ingredients by crop ingredients); and (2) implement systems such as closed-systems or polyculture, that allow efficient management of nutrients without creating burden-shifting with energy demand.